Joint Meeting of Action Team on GNSS

United Nations/United States of America International Workshop on the Use and Applications of Global Navigation Satellite Systems

8-12 December 2003,Vienna, Austria

Report on the Survey on the Thematic Area "Training and Education, Awareness Increase" on follow-up initiatives of the UN/USA GNSS Regional Workshops and International Meeting of Experts 2001-2002

Fernando Walter

(Responsible Expert)

Carlos Vettorazzi, C. Merry, Elod Böth

(collaborators)

1. INTRODUCTION

A. Background

At the third United Nations/United States of America Regional Workshop on the Use and Applications of Global Navigation Satellite Systems (Santiago, Chile, 1-5 April 2002) it was decided that an effort towards on Education on GNSS was necessary to be taken.

The main issues presented at that third Regional Workshop were that developing countries urgently needed qualified personnel to meet the challenges posed by GNSS and its demanding applications to aeronautics, geomathics, Earth science, etc.

In that context, interdisciplinary teams of professionals are increasingly needed to carry out project development.

The great variety of equipment now available in the market, in addition to the huge amount of information appearing in the media such as Internet, give way to situations that are confusing and might prove to be potentially dangerous.

Again, the need for personnel with the right training, able to produce practical and economical solutions to the different problems that might arise, is here stressed. This aspect shall be accomplished as long as the technology and its uses are rightly assimilated.

There are clear differences between education and training. These differences must be clearly identified in order to determine the needs inherent in the formation of qualified human resources at the various levels. They may be simple user, advanced and/or executive user.

Several formation centers offering specialized courses in GNSS and its applications have been established. They offer specialized training covering mainly in aeronautics and airspace matters at the regional, national and even hemispheric levels.

B. Suggestions

Considering the above stated facts, the respondents made numerous suggestions. Some of the most relevant are:

1. To encourage the realization of joint projects between the formation centers in the region in order to avoid duplicating efforts and to manage financial resources efficiently. Thus, major access to funds dedicated to study and equipment shall be attained. Student and professionals exchange would also favor integration at Latin American level.

2. To carry out a regional investigation to identify the different formation centers existing in the area, the courses they offer and the degrees they extend.

3. To promote wide spread information about the available tools and procedures related to educational matters offered by international organizations, as the United Nations and AEO have on GNSS training.

4. To carry out regularly itinerant training courses at technical level to prepare post degree programs.

5. To conduct intensive use of the Internet media in order to increase the number of discussion boards related to GNSS training. The same media could provide introduction of specialized texts in Spanish and Portuguese languages.

6. The promotion of the project on a cost-benefit analysis is bound to facilitate resources from the political media directed to education and the use of GNSS to satisfy the needs of our societies.

7. To encourage manufacturers of equipment to cooperate with the educational institutions making services and equipment available to them.

C. Survey of Existing Training Opportunities (summary)

I. Universities and Research Institutes

The following Institutions/Organizations were identified at undergraduate and graduate levels:

- Africa: Courses are taken in Portuguese universities.
- Brazil: Universities and research institutes.
- Canada: Universities and research institutes.
- Colombia: Starting a graduation (post-graduation) program
- European Commission: Universities and research institutes.
- Poland: Isolated actions taken at Warsaw University.
- Portugal: University of Porto (Faculty of Sciences).
- Russian Federation: Universities and research institutes.

II. Training

- China: Organizing a GNSS technology training workshop.
- Portugal: A project to disseminate the use of GNSS at high school level.
- Uzbekistan: The materials from the workshop are being used in educational activities.

D. Suggestions

A majority of representatives from different countries found the initiative taken by the UN and the USA Government having a positive impact in their countries. The materials produced during the workshops have been used in different ways, not only as documentation to show to the authorities, but also as material for teaching. It is important to notice the need of experts in the GNSS area to provide courses in different levels. Some countries do not have funds for procuring GNSS equipment, which is rather expensive.

We noticed that many countries do not have a governmental institution that can congregate personnel working in the field of GNSS, which certainly make the work in these countries rather hard and disperse.

The suggestion is, under the UN support, to have regional offices (for instance the Center for Space Science and Technology Education, supported by UN) to administrate the works conducted in regional areas (Western Asia, Asia and the Pacific, Africa, Eastern and Central Europe, and South America and the Caribbean).

Some countries could accept foreign students to their graduate program (post-graduation).

Set up special funding for training and infrastructure. More participation of the manufacturers is required.

Some countries advised that the reports of the UN/USA workshop should be sent, through official UN channel, to governments of countries involved.

It is important to quote the interdisciplinary aspect of the GNSS, which demands for involvement of professionals from different areas (Table I).

Table I:
Multidisciplinary Telecommunications Laboratory

The GNSS Laboratory program allows it to be used as a multidisciplinary Telecommunications Laboratory comprising:

Topics	Application Areas
Linear Algebra	-Navigation calculus and coordinates changes -Coordinates calculus with short and extended base lines -Expected Doppler shifting -User – satellite geometry
Adaptive Filtering	-LMS and LS algorithms applications for navigation -Blind deconvolution, LMS and LS for multipath rejection -Antennas arrays and spatial filtering (*smart antenna*)
Spread Spectrum Systems	-PRN codes generation -Autocorrelation in the acquisition and tracking processes
Digital Communications	-Generation and simulation of the signal expected in the receiver -Frequency planning -Digital modulation: BPSK
Atmospheric and Propagation modeling	-Current ionospheric models; Klobuchar model for GPS -Analysis of the Ionospheric model of SBAS -Ray tracing
Signal Tracking with PLL/Costas Loop	-Tracking process -Coherent and non coherent PLL -Signal real and complex processing
Detection and Estimation Theory	-Acquisition process
Codes Theory	-Generation and decoding of navigation messages. -Generation and decoding of differential corrections.
Digital Signal Processing	-Sampling and ADC in the RF processing block in the receiver. -Autocorrelation

It is important to mention the participation of manufactures to give special courses for training people to train other professionals.

The graduate curses are important to train very specialized professionals, once they conduct research on the area, such as effects of the Equatorial Anomaly in GNSS signals (see

Annex), GNSS software receivers, special antennas for multipath mitigation. These are examples of some topics that could be of study at graduation level.

Table II shows a summary of topics that could be given at graduation level:

Table II:
Summary of the Program

First level:

Topics	Subtopics
Basic Geodesic Concepts	-Orbit representation (projections and maps) -ECEF and ECI systems -Lat/Long/Alt and UTM coordinates -Reference ellipsoids and local datum (WGS-84) -Datums and the geoid's problem
Navigation Basic Topics	-Navigation history -Triangulation -Trilateration -Dilution of precision (DOP)
Orbital Concepts	-Kepler's laws -Sideral day -Ephemeredes and Anomalies

GPS Basic Topics:

Topics	Subtopics
General Description of the GPS System	-Beginning and history -Constitutive segments and expected performance according to FRP and ICD-GPS 200 -Employment principle: Time of Arriving(*TOA*)
Spatial Segment	-Satellites constellation: orbits and coverage -Generation of navigation signals and messages -Expected power -Real orbits data
Control Segment	-Description -Ephemeris constitution
User's Segment	-Receiver description -URA, UERE and RAIM -Use of GPS receivers practice: data acquisition and processing. -Use of GPS receivers practice: differential corrections.
Analysis of error and perturbation factors	-SV and user clock errors -Delays due to atmospheric effects -Noise, resolution and hardware -Selective Availability (SA) -Multipath -User – satellite geometry

Simulation and Analysis of Receiver's Processes	-PRN Code generation -Doppler shift -Frequency planning and direct digitalization -Acquisition and tracking Navigation message decoding and satellite coordinate calculation

Advanced GPS Topics

Topics	Subtopics
Pseudolite	-Analysis and improvement of DOP
Differential GPS	-Receivers errors correlation in the same geographic region -Messages in RTCM-104 format -Messages in RTCA format
GBAS and SBAS	-Atmospheric local models -Ionospheric models -Expected characteristics and performance
Attitude Determination	-Actual speed calculation -Quaternion use
Statistic Modeling	-ARIMA models -Integrity control
Receiver's Architectures	-Multipath reduction -Tracking algorithms
Systems Integration	-GPS and inertial platforms

E. Conclusions

Education is the key word, independent of the application area of GNSS. The results of the promoted Workshops show to be a good way to gather specialists from different countries and areas together. However, it is also important to notice that in the near future courses in different levels prepared by experts in GNSS are to be given with participation of manufactures. Parallel with the Workshop, or in the preceding week, seminars with one week duration could be given in three different levels: Basic (mainly for final users); Intermediate (mainly for engineers); and Advanced (special topics for people with a good background in GNSS).

The GNSS is a good tool to be used for students to apply the knowledge learned at the undergraduation level.

To encourage development of GNSS software receivers that are more inexpensive than the ones in the market and represent a good tool to teach how GNSS works. Many courses are conducted at the graduation level (post-graduation).

ANNEX

Illustration of a work developed by a graduate student: Study of the Equatorial Anomaly. Maps (Fig. 1) from 1999 up to now show the behaviour of the TEC in function of Kp index in the global way it was developed.

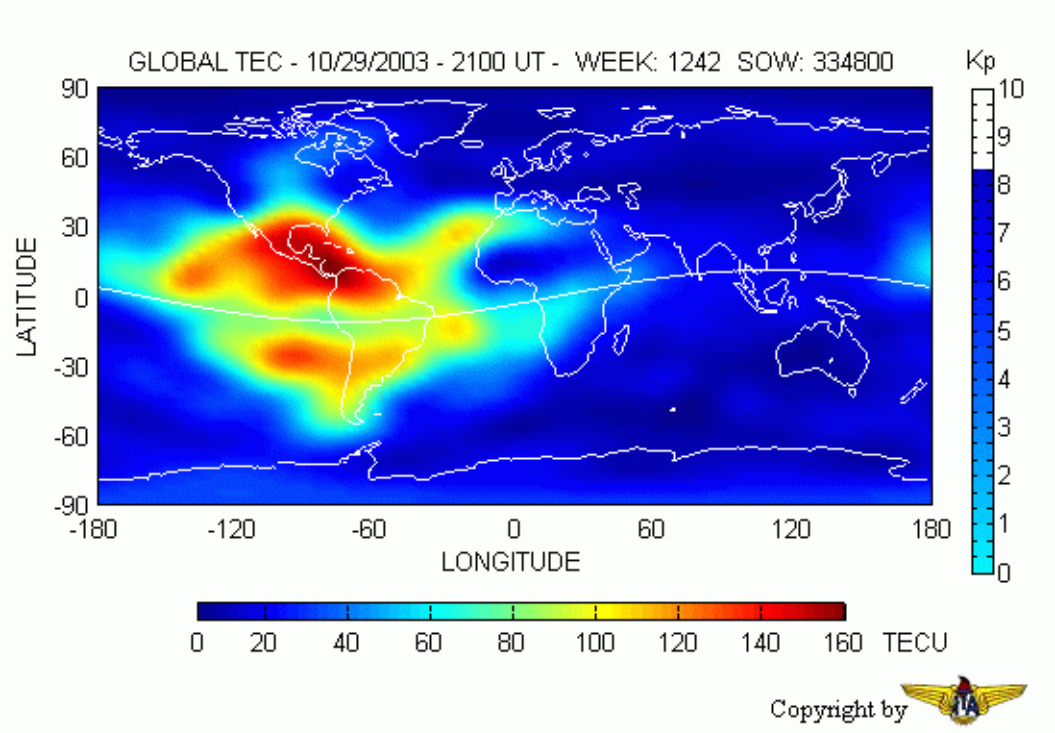

Figure 1: Effects of the Solar Storm occurred in October 29, 2003 in the Equatorial Anomaly.